Space Weather Technical Forecast

Issued on Wednesday, 08 February 2023 at 01:35 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Further M-flares (R1/R2 Radio Blackouts) likely during the period.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is at Moderate levels with four M-class flares observed in the past 24-hours. The peak flare was an M6.3 event at 07/2307 UTC from AR3213 near the centre disc in the northern hemisphere. This is one of eight sunspots currently on the visible disc. The most developmental regions are currently AR3213 (Dai/Beta-Gamma-Delta) and AR3214 (Dhi/Beta-Gamma), the latter being located in the northeast, with ongoing growth observed in both. A large filament remains present across the southwestern hemisphere, however this currently appears stable. No Earth-directed CMEs have been observed. The trajectory of a CME from AR3213 resulting from a C5.8 flare at 07/1232 UTC has been assessed, but is expected to be directed above Earth's orbit.

Solar Wind / Geomagnetic Activity: Solar winds are currently at elevated to slightly elevated levels, having increased earlier in the UTC day due to Earth interacting with the fast wind from coronal holes 74 and 75 and subsequently decreasing later. Observed speeds at L1 increased from 450-500 km/s to peak at 550-600 km/s around 07/0800 UTC, before easing to around 470-510 km/s by the end of the period. The density of the solar wind has been largely below average. Total IMF strength, Bt, was Moderate at first, with a peak value of 11nT around 07/0000 UTC, but has since eased to become Weak from around 07/1600 UTC. The north-south component Bz, was variable, but more generally southward directed ranging -10nT to +7 nT. Phi angle was mainly negative (towards the Sun). Geomagnetic activity was Unsettled to Active (Kp 3-4).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 remained at Background levels throughout. The high energy electron flux (greater than 2MeV) measured by GOES-16 was predominantly at Background levels, though increased to become Moderate from around 07/1500 UTC. The associated 24-hour electron fluence was below the Active level, but on a rising trend, with the observed fluence at 07/2359UTC being 7.93e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected, with a slight chance of High levels being reached, mainly owing to the developing sunspots in the northern hemisphere, as well as further regions expected to rotate onto the disc during the period.

Solar Wind / Geomagnetic Activity: CMEs which left the Sun on the 4th, 5th and 7th, while forecast to miss the Earth, give a low chance of glancing interactions between Days 1-4 (8th-11th). Otherwise, the ongoing elevated solar winds due to the fast wind enhancement from CH74 and CH75 are forecast to gradually ease, with no other coronal hole sourced enhancements expected. Mainly Quiet to Unsettled geomagnetic activity is expected, however given current fast winds and the low confidence CME outlook, Active intervals are possible on all days. There is a very slight chance of G1/Minor Storm intervals at any time during the period.

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Met Office Space Weather Technical Forecast

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at background levels, but with a slight chance of an S1+ event on Day 1 (8th) owing to the M6.3 flare from AR3213 at 07/2307 UTC. High energy electron flux is expected to rise from Background to Moderate levels, to become more persistently Moderate on Day 1 (8th), with a chance of reaching High levels. Similar conditions are expected on the remaining days but likely falling again to mainly Background levels by Day 4 (11th). The associated 24 hour fluence is expected to continue to rise in response, but likely remain below the Active threshold (1e8 integrated pfu).

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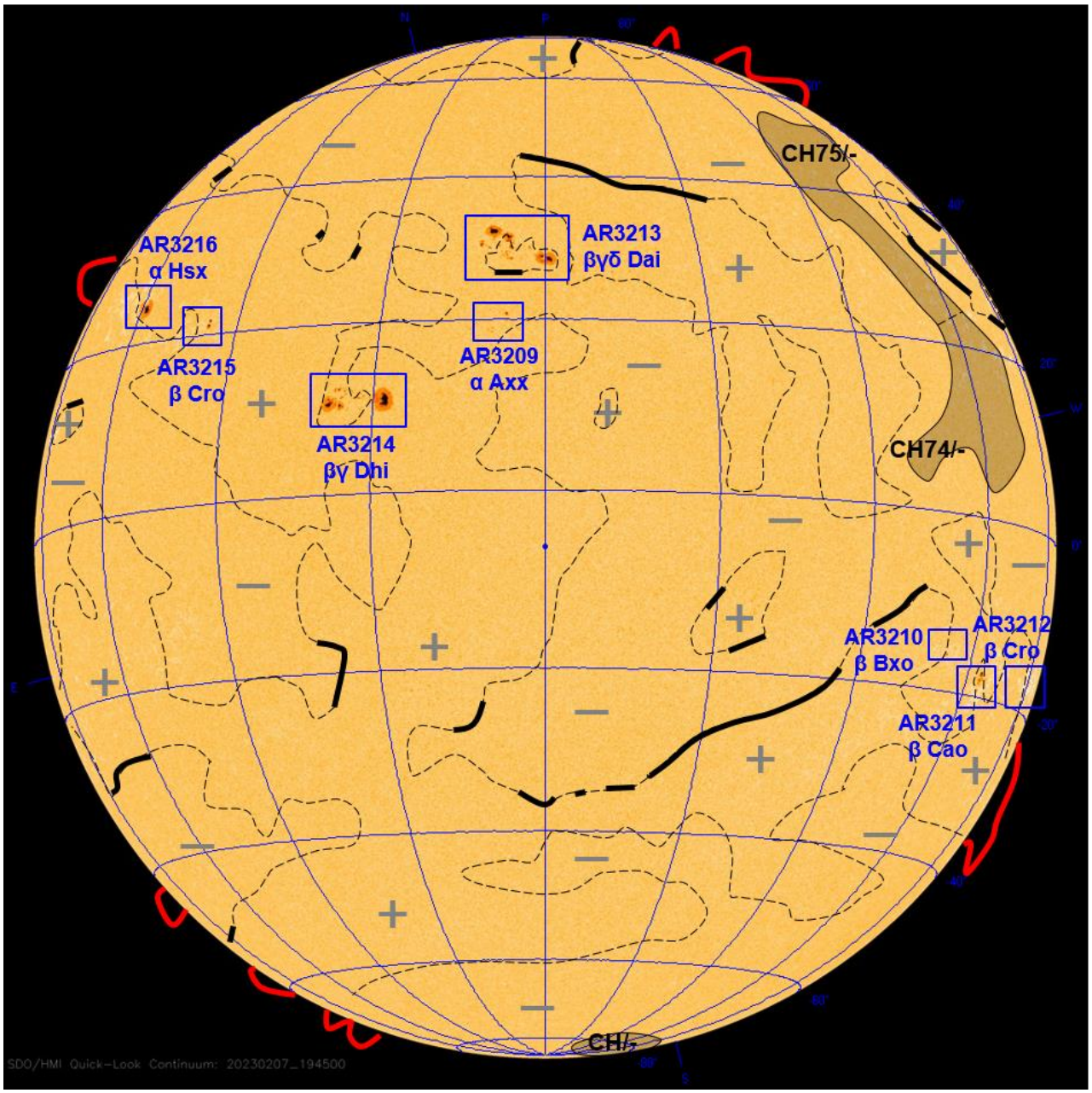
Figure 1. Solar Analysis Valid 07/1945 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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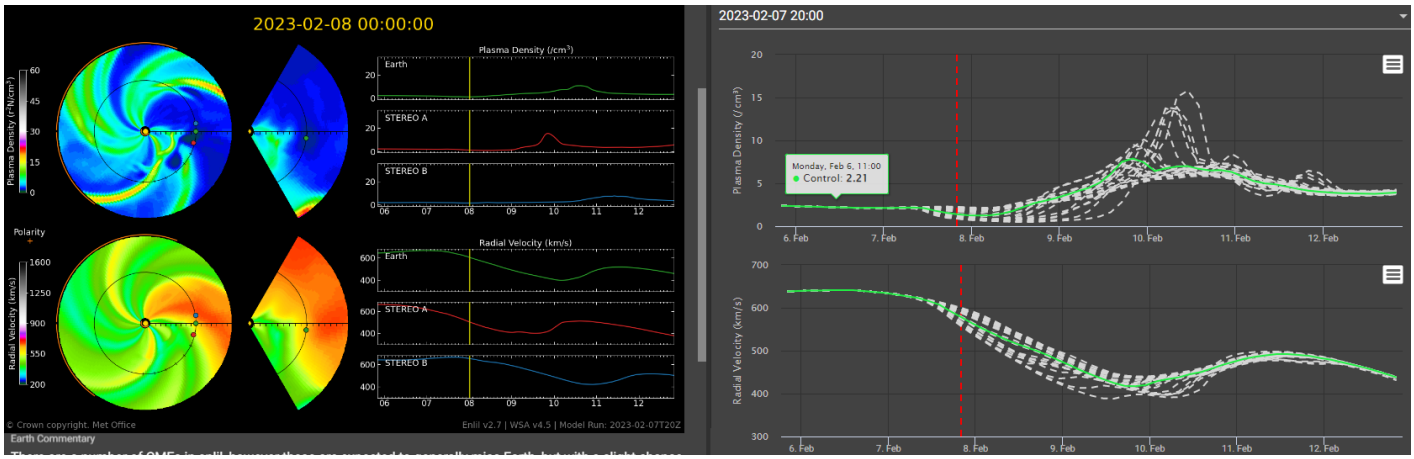
Geomagnetic Storms:

A number of CMEs are expected to miss, but pass close to Earth over the coming several days. These left the Sun on the 4th, 5th and 7th and given some uncertainty in their analysis, may give some peripheral interactions between Days 1-4 (8th-11th). Confidence is reduced further due to enlil currently over estimating the strength of the current fast wind environment. This is due to Earth moving through the fast wind originating from coronal holes 74 and 75. These solar winds are expected to ease through the period, with no further enhancement expected.

Mainly Quiet to Unsettled geomagnetic activity is expected, however given current fast winds and the low confidence CME outlook, Active intervals are possible on all days. There is a very slight chance of G1/Minor Storm intervals at any time during the period.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	5	5	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: Latest MOSWOC Enlil and Ensemble



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Radio Blackouts - X-Ray Flares:

Solar activity is currently Moderate with eight sunspot regions currently on the disc. Activity is expected to be Low to Moderate with a slight chance of High levels being reached.

The most developmental groups are AR3213 (Dai/Beta-Gamma-Delta) in the northern centre disc and AR3214 (Beta-Gamma) in the northeast quadrant. AR3213 has grown rather quickly and has acquired a small delta spot in the intermediate to rearward part of the group. This region was responsible for an impulsive M6.3 flare at 07/2307 UTC, along with a further couple of lower M-class flares earlier in the UTC day. AR3214, the larger of the two regions, has seen weak intermediate spots develop in recent hours of opposite magnetic polarity, meaning this carries a Beta-Gamma Mount Wilson magnetic classification. In addition, the large leading spot can now be classified as an 'h' spot, therefore is a Dhi region according to the Modified Zurich classification method. The other regions on the disc are smaller and simpler at this time.

Although a number of small regions are soon to rotate off the southwest limb, further regions are expected to rotate onto the disc in the coming day. This includes ex-AR3190 and ex-AR3194 in the southeast, both of which were sources of flare activity on their previous transit, as well as ex-AR3191 and ex-AR3192 in the northeast. With some notable magnetic looping also evident on SDO aia-171 and STEREO A euvi imagery, this adds to the risk of flare activity through the period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	50	50	50
Very Active	R3 to R5 X Class	No	10	10	10	10

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Figure 3: GOES16/18 X-ray flux

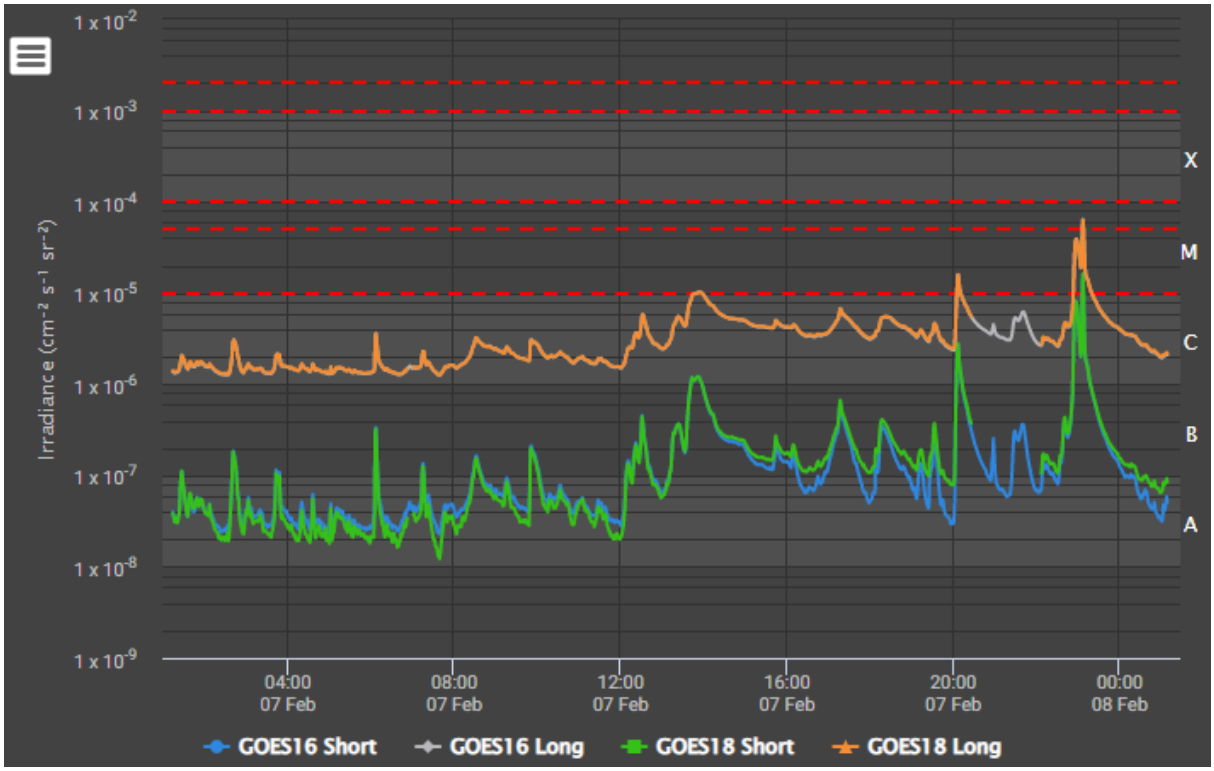
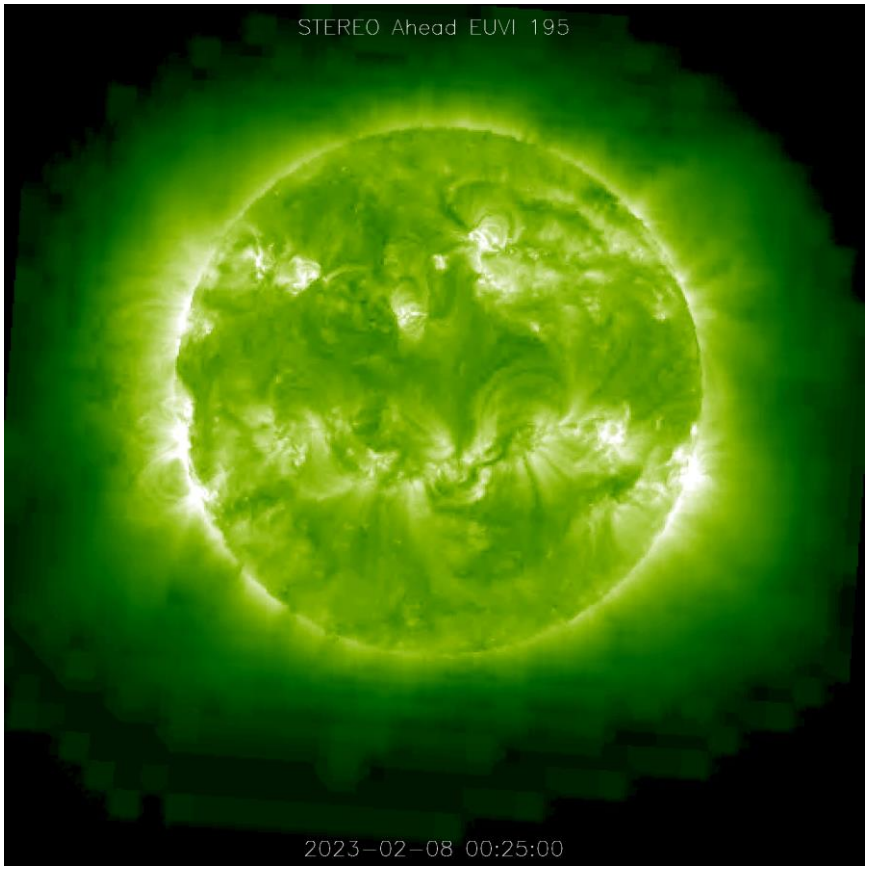


Figure 4: STEREO A EUVI 195 08/0025 UTC imagery indicating new regions on eastern limb soon to rotate onto visible disc from Earth.



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Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux as observed by GOES16 is currently at background levels. The M6.3 flare at 07/2307 UTC from AR3213, gives a slight chance of an S1+ proton storm event on Day 1 (8th), based on historical records of similar flares observed from this part of the disc. Otherwise a very slight chance of S1+ proton storm events is expected, increasing marginally by Day 4 (11th) as the two largest sunspot regions (AR3213 and AR3214) transit into a more favourable location on the disc for Earth-directed effects.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	5	5	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) as observed by GOES16 is currently at Background to Moderate levels on a diurnal cycle. This is likely to rise to become persistently Moderate at times during the period as a consequence of the recent slight enhancement to the geospace environment from the arrival of coronal hole fast winds from CH74 and CH75. This will bring a chance of reaching High during diurnal maximum by the end of Day 1 (8th). Similar conditions are expected on the remaining days but likely falling to mainly Background levels again by Day 4 (11th) as the electron belts return to background state again.

The associated 24 hr fluence is likely to continue to rise, but expected to stay below the Active threshold (1e8 integrated pfu). REFM suggests a generally flatter trend, however this is currently poor guidance, as it likely doesn't yet account for the recent enhancement to solar winds.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	20	20	20	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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Figure 5: GOES-16 Electron flux (above) and Fluence forecast with REFM (below)

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